ARIZONA TRANSPORTATION RESEARCH CENTER

RESEARCH NOTES:

Project SPR-588

August 2008

Evaluation of Distribution and Trans-Highway Movement of Desert Bighorn Sheep: Arizona Highway 68

Highway construction can affect desert bighorn sheep (Ovis Canadensis) populations by increasing habitat fragmentation and isolation which can impede access to critical habitats, increase effects of stochastic events and reduce gene flow. With the rapid expansion of road networks in proximity to bighorn habitat, and the increased use of high animal fencing along such roads to reduce wildlife/vehicle collisions, the need for proper design and placement of wildlife crossing structures is imperative to allow for animal movement and reduce the potential for habitat fragmentation.

Three wildlife crossing structures (underpasses) were incorporated into the realignment and improvement of State Route 68 between Kingman and Bullhead City, Arizona, to facilitate movement of bighorn. State Route 68 was realigned and widened from a 2 lane to a 4 lane highway over a 14 mile stretch from County Route 68 to Mile Post 14 between the years 2000 and 2002. To evaluate the effectiveness of the different underpasses we fitted 25 bighorn with GPS radio telemetry transmitters and tracked movements in proximity to the highway for 22.5 months beginning in November of 2006. To evaluate use of underpasses by all ungulates we installed 5 remote passive infrared triggered cameras at each underpass.

Study Area

The study area was located in northwestern Arizona in the Black Mountains within 10 miles north and south of SR 68 and was bounded on the west by the Colorado River and by Golden Valley to the east. Elevation of the study area ranged from about 146m/ 479ft on the Colorado River to 1,496m/ 4907ft. Topography ranged from mountainous terrain with steep talus slopes and rugged cliffs to dry washes among rolling hills. Average temperatures ranged from 31ºC/88ºF in summer (May–September) to 12ºC/54ºF in winter (December–February). Rainfall was about 5.6 cm/ 2.18 in and 4.7 cm/ 1.83 in during summer and winter respectively, and totaled about 15.4 cm /6 in annually. Vegetation in the lower bajadas, flats and desert wash areas is dominated by Creosote-bursage (Larrea tridentata-Ambrosia dumosa) while mixed-cacti and shrub communities predominate the mountainous regions of the study area. Predators on the study area included bobcats, coyotes, gray foxes, and mountain lions. Domestic livestock were infrequent in most of the study area, except that feral burros were common. Based on aerial surveys, numbers of bighorn in the general area declined sharply between 2001 and 2004 according to Arizona Game and Fish Department documentation. Legal hunting of bighorn occurred during the month of December each year.

Capture and Telemetry

Adult bighorns were captured from a helicopter using tranquilizer darting in November 2005 and via net-gunning in November of 2006. GPS radio transmitter collars and unique ear tags were securely attached to all bighorns. Transmitters were equipped with motion sensors triggering a specific mortality signal if no animal movement occurred within 4 hours. Transmitters were designed to provide a GPS location fix every five hours for the store-on-board transmitters and every six hours for the spread-spectrum transmitters. All collars were programmed to automatically disconnect and drop off animals after 22.5 months for transmitter recovery. Animal location data could be uploaded remotely from spread-spectrum transmitters during a 3-hour window available every 14 days, and after final recovery. Animal location data collected on store-on-board transmitters could be downloaded only after collar drop off and recovery.

Aerial telemetry flights were conducted bi-weekly to monthly between November 2005 and September 2007 using fixed-wing aircraft to download data from spread-spectrum transmitters, locate bighorns fitted with store-on-board transmitters, and document and locate any mortalities. We incorporated data from spread-spectrum transmitters into ArcGIS® Version 8.3 software following each flight, and incorporated data from store-on-board transmitters following collar drop-off and recovery at the end of fieldwork or when transmitters were retrieved from mortality sites. We identified cause of death for each mortality investigated based on signs found at the carcass site, including signs of disease, presence of scats, tracks, caching of kill, and canine punctures.

Cameras and Track Beds

Five remote passive infrared triggered cameras were deployed at each of the three underpasses along SR 68. We programmed 4 cameras to take 30 pictures (one picture every quarter of a second) each time movement was detected, and record date, time and temperature on each image. We positioned cameras for full coverage of the underpass to record wildlife use of crossing structures. We also positioned cameras to cover approach trails near the underpasses to document wildlife that approached crossing structures without crossing. We deployed one video camera at each underpass that was programmed to take a 90 second video each time motion was detected to better document wildlife behavior in proximity to the SR 68.

We developed track beds at each of the three underpasses along SR 68 to supplement data collected by the cameras. Each track bed was at least two meters wide and all were of variable length depending on the underpass. We counted tracks once a week, and cleared and restructured track beds after each examination.

Analysis and Conclusions

Impacts of highways are some of the most widespread factors altering natural ecosystems in the United States. Collisions of vehicles with wildlife result in extensive human deaths, injuries, and property damage. Impacts of highways due to barrier and fragmentation effects on wildlife populations are widespread. Highways block animal movements, reduce habitat connectivity, fragment habitats and populations, and contribute directly to mortality of wildlife.

We found that desert bighorn sheep used wildlife underpasses but that use was restricted to 12% of marked animals and consisted of only rams. Others have found 61% of deer migrated safely using underpasses, 89% of mountain goat crossings were successful, and up to 96% of elk (Cervus elaphus) used underpasses in various areas. Some studies indicate use of underpasses may increase over time but also reported reluctance for deer to use underpasses even after 10 years.

Environmental features associated with underpasses influence their use by ungulates. The most commonly used underpass on SR 68, Union Pass, had the highest availability of steep rugged terrain. Bighorn use of Arabian Mine was higher than The Hole although availability of steep rugged terrain was higher at The Hole. A study on US 93 found bighorn use of habitat near highways was associated with Continuous Linear Elevated Guideways (CLEG), ridgelines that offered good visibility and connected habitats on both sides of the highway. Although escape terrain (areas ≥ 60% slope) was more available near The Hole, the main spine of the Black Mountains and associated CLEG was located well to the east

Recommendations

Design and placement of crossing structures will influence highway permeability to bighorns, and more natural structures connecting suitable bighorn habitat will increase effectiveness. Connecting high quality habitat on both sides of the road especially in areas with escape terrain will increase the likelihood that a structure will be encountered. Placement of structures should be along existing travel routes whenever possible. Underpasses in particular need to have a high index of openness: (height x width)/ (length); the higher and wider the more effective a structure will be. The index of openness at Union Pass, the underpass used most by bighorns, was 75 and may represent a minimum since we documented three approaches that resulted without crossing, which could have been due to inadequate visibility. Higher index of openness would likely have increased permeability at this site. Visibility through the underpass is critical for animals approaching the structure. Following are recommendations for improvement of each of the existing underpasses.

A. UNION PASS (Mile Post 12.1)

1) Recontouring the side slopes to remove the shadowed bench that is along the abutment on the northeast side of the underpass could enhance bighorn use by reducing vigilance behavior associated with that feature. Many bighorns crossing at Union Pass stopped and looked with suspicion at the shaded area before proceeding.

2) Stabilizing substrate along the steep slopes beneath the underpass and adding a small game trail about half way up may increase bighorn use. Currently due to the loose steep sides of the underpass the

bighorn cross at the bottom, where their predator detection/avoidance strategies are compromised. A shelf below and extending the length of underpass abutments may provide easier access and a feeling of security to bighorns.

B. THE HOLE (Mile Post 10.8)

Many of the factors affecting bighorn use of underpasses: proximity to traditional movement corridors, terrain features, index of openness, and presence of other animals, are problematic at The Hole. The index of openness is likely the only factor that could be addressed here. However, given the high burro use and the relatively low probability that bighorns would encounter this site, restructuring the underpass to increase the index of openness would likely be ineffective.

C. ARABIAN MINE (Mile Post 7.8)

1) Reducing the amount of human activity at the underpass and preventing vehicle access to the wash on either side of the highway at Arabian Mine may enhance bighorn use.

2) Recontouring the side slopes to remove the shadowed bench that is along the abutment on the northwest side of the underpass could enhance bighorn use by reducing vigilance behavior associated with that feature. All the bighorns that crossed here avoided this feature.

Right-of-way fencing should exceed two meters in height throughout all potential bighorn habitats. We estimated that one marked ram crossed the highway in an area where right-of-way fencing was low (MP 8-10), and the single bighorn/vehicle collision was documented in this same area. Right-of –way fencing between MP 8 and 10 should be raised to two meters high and the high right-of-way fencing should also be extended further east from MP 12.5 to at least MP 13. Frequent monitoring of right-of-way fencing is necessary to identify breaches that bighorns could cross, especially in areas with high erosion potential. Jump-outs designed to allow bighorns to climb up a ramp of rocks and jump out of right-of-way fenced areas could reduce potential for bighorn/vehicle collisions when right-of-way fences are breached. Jump-outs should be 2.5 meters or higher to ensure bighorns can't jump over into the right-of-way.

The full report: *Evaluation of Distribution and Trans-Highway Movement of Desert Bighorn Sheep: Arizona Highway 68,* by Kirby Bristow and Michelle Crabb, Arizona Game and Fish Department Research Branch, 5000 W. Carefree Highway Phoenix, AZ 85086 (Arizona Department of Transportation, report number FHWA-AZ-08-588, published July 2008) is available on the Internet. Educational and governmental agencies may order print copies from the Arizona Transportation Research Center, 206 S. 17 Ave., MD 075R, Phoenix, AZ 85007; FAX 602-712-3400. Businesses may order copies through ADOT's Engineering Records Section.